Sustainability Success Stories

Environmental Health and Safety is assisting research laboratories to become more energy efficient and reduce exposures, while educating staff and students on how they can save energy and reduce costs and waste. The following are a sampling of our success stories.

FLUORESCENT BULBS

EHS collaborates with Facilities and onsite electrical contractors to collect and recycle all used fluorescent bulbs in Yale-owned buildings. This includes four-foot, eight-foot, U tubes, O tubes and compact Fluorescent lights (CFLs). In 2008, Yale recycled over 210,000 feet of bulbs, the equivalent of 40 miles if stretched end to end. The recycling process removes and captures the mercury containing gas while cleaning and reusing the glass.

LABORATORY EQUIPMENT

The Keck Foundation Laboratory, located at 300 George Street, purchased three Applied Biosystems 3900 oligo synthesizers to replace three Applied Biosystems 3948 oligo synthesizers. The new synthesizers have the same process functionally and generate the same hazardous waste stream, but generate less hazardous waste. This change reduced the flammable waste stream by 55 percent or roughly 88 gallons per month. It also led to a reduction in waste generation and the amount of chemical solvent purchased as well as a reduction in the risk of spills or exposures. The change resulted in an annual savings of roughly $5,300.

LEAD SHIELDING RECYCLING

Environmental Health and Safety collects and recycles lead in the form of pigs, bricks and other shielding. The lead is recovered and smelted into new product. In 2008, Environmental Health and Safety recycled 2,000 pounds of lead.

MEDICAL WASTE PLASTIC REDUCTION

In 2003, Environmental Health and Safety purchased and installed a large autoclave and shredder unit at the Yale School of Medicine. Instead of transporting all of Yale's medical waste off site for processing or incineration, Yale can now safely process medical waste on campus through autoclaving and then shredding to render the waste unrecognizable. The waste is then mixed with other normal solid waste generated at the medical school. This has resulted in benefits for reduction of long-term liability of this waste stream as well as the reduction of plastic medical waste containers once used for collection and autoclaving at the laboratory level. These buckets have been replaced by cardboard box units resulting in a reduction of plastic in the medical waste stream by 70 percent. In addition to the reduction of plastic usage, the laboratories do not need to autoclave BSL-1 and most BSL-2 waste streams at a local level. This has reduced autoclave usage and energy consumption.

MERCURY REDUCTION

Many of the spills that occur on campus during and after work hours involve the spill of mercury. The source of mercury is mainly from thermometers or other mercury-containing equipment. Mercury is a highly toxic element that is persistent in our environment and its primary route in humans is ingestion of contaminated fish and wildlife at the top of the food chains. Connecticut's rivers and watersheds have been identified to have significant mercury contamination resulting in limitations on fish and shell fish consumption.

The expense for calling in emergency responders off hours and the expense of disposing of spill cleanup material can be in extremely costly over the course of the year. For the last decade, a program has been

implemented through Environmental Health and Safety to reduce the number of mercury spills and the generation of mercury-contaminated hazardous waste. For every one mercury-containing thermometer that is returned to the Medical Stockroom, the Chemical Stockroom or the West Campus Resource Center, the lab personnel will receive a free red spirit thermometer (-20C to 110C in 1 gradients). Tests conducted show that the model of red spirit thermometer used in the exchange program equals or exceeds the accuracy and precision of ordinary mercury thermometers. Over 2,000 thermometers have successfully been removed from campus and safely disposed.

In addition, Environmental Health and Safety has worked with many departments and conducted cost benefit analysis for aging or unnecessary mercury-containing devices such as manometers and mercury-containing thermostats. These efforts have resulted in a large reduction of mercury-containing equipment on campus.

MICROSCALING

In 1995, as a result of a RCRA inspection and penalty from the EPA, Yale entered into an agreement with the EPA to perform Supplemental Environmental Projects (SEP) for a portion of the assessed monetary penalty. One of these SEP's was to introduce Microscale equipment in the two large undergraduate chemistry labs on campus. Four hundred kits were purchased at $107.42 each for a total of $42,968. The following table illustrates potential savings and waste reduction.

Experiment	**Traditional Cost**	**Micro Cost**
Acetanilide	0.46	0.05
Aldol Condensation	5.20	0.23
Sodium Borohydride Reduction	0.16	0.02
Electrophilic Aromatic Substitution	1.01	0.02
Diphenylacetylene	0.99	.10
Tetrapheynlcyclopentadienone	2.11	0.08
Total cost per student	**$9.93**	**$0.50**

Data from 1995 Aldrich catalog

Microscaling decreases the volume of hazardous chemical waste generated in the undergraduate labs on campus and improves student safety by decreasing the potential for chemical exposure. It improves air quality, reduces air emissions due to reduced volumes of solvents and other volatile chemicals and reduces the potential for large hazardous chemical spills in the lab. Microscaling decreases the amount of storage space needed for stock chemicals, decreases the hazards involved in storage and allows students to become aware of waste minimization at the source. Disposal costs should be reduced by about 10 percent since that is the volume used in a typical microscale versus macroscale experiment.

In the future, undergraduate labs may also use computer simulations to see a wider variety of experimental results without generating hazardous chemical waste and saving time. Experiments will not have to be repeated again and again at a bench-scale level, but can be seen by the use of computer software. There are computer software vendors that are producing chemical reaction simulation software.

PARTS WASHERS

Parts washers are used throughout campus to clean tools and other components using a solvent to dissolve the dirt and grease. Environmental Health and Safety has worked with each department and Yale Purchasing to see if they were willing to change vendors to reduce hazardous waste generations. Six parts washers located throughout the University were replaced with units that use a petroleum distillate-based solvent rather than an ignitable solvent. This switch allowed an entire hazardous waste stream to be eliminated resulting in a safer and healthier alternative, a reduction of roughly 2,000 pounds of hazardous waste annually and an annual savings of roughly $2,300 per year.

PRINTING WASTES

In June 2008, the AM&T Media Services at 59 High Street switched to using digital photography due to client demand, image quality and the high costs of chemicals used in the black and white film processing. The equipment used to process and develop film was taken out of service and photographic editing waste, which is hazardous due to high levels of silver in the waste solution, was eliminated. This resulted in a reduction of 60 gallons of hazardous waste per year and eliminated the risk of hazardous chemical exposures and spills.

Additionally, the Yale Reprographic and Imaging Services (RIS) print shop at 155 Whitney Avenue purchased a new Mitsubishi Image Silver Master camera plate maker to replace an old plate maker. The new plate maker provided the same functional process, but used slightly different chemistry and generated one non-hazardous, state regulated chemical waste stream. The new equipment reduced waste by 85 percent or roughly 100 gallons per year. Along with being more reliable and easier to maintain, the new equipment reduced the amount of chemicals purchased, waste generated and the risk of exposure and spills. The change resulted in an annual savings of $408 per year.

SILVER RECOVERY

Beginning in 2007, the School of Art at 1156 Chapel Street agreed to have a silver recovery unit installed in both the undergraduate and graduate developing areas. The recovery cartridges collect the silver from the used fixer waste stream and the effluent is safe for drain disposal. A year later, the School of Art also decided to change most of its processing to digital photography, reducing hazardous waste generation even further. The change resulted in the elimination of 1,880 gallons of hazardous waste per year, a reduction in ergonomic hazards associated with handling and transporting waste and the elimination of storage and handling of stock chemicals. The annual savings is roughly $6,000.

SOLVENT RECOVERY

Environmental Health and Safety purchased solvent distillation unit for Professor Christine Dimeglio’s teaching labs in Sterling Chemistry Laboratory using grant money awarded by the University Provost’s Advisory Committee on Environmental Management (ACEM). This unit is used to recycle acetone waste generated by cleaning glassware. The cleaned acetone can be re-used repeatedly. This resulted in the elimination of 104 gallons of acetone hazardous waste per year and had a cost savings of roughly $2,000 annually.

VENTILATION ENERGY REDUCTION

Since 2001, Environmental Health and Safety and Facilities Engineering have performed a series of investigations into safely reducing lab ventilation rates. Initial air quality testing in several chemical intensive labs permitted incremental airflow reductions. More recently, the testing was refined and identified additional opportunities for further reductions, provided that HVAC supply and exhaust system components are appropriate for the new flowrates. Implementation of these collective recommendations since 2001 has saved hundreds of thousands of dollars in energy costs and reduced initial capital expenses in new construction.

Applied research during the design of the new Chemistry Research Building verified that fume hood flow set-back rates could be lower than ordinarily possible and still not create fire/explosion hazards with the common solvents used in chemistry. This work reduced initial capital costs on HVAC equipment systems and has also provided long-term energy savings by reducing airflows during non-occupied, non-use times.

Ongoing Environmental Health and Safety fume hood inspection and certification work identifies misused fume hoods as well as those operating with too high an airflow and arranges for prompt repair and recalibration. This makes for safer and more energy efficient fume hoods.